A training exercise for military teams demonstrated how ARTHR payloads can protect and assist first responders by enabling robots to locate and identify hazardous materials, and to establish safe or unsafe areas and routes.

ARTHR gives robots the brains to detect threats

by Nicole Stricker, *INL Communications*

U.S. soldiers and first responders could soon have their own version of a bomb-sniffing dog — a robotic payload named ARTHR developed at Idaho National Laboratory. The Autonomous Real-time Threat-Hunting Robot (ARTHR) intelligence system enables a variety of robots to search dangerous environments for explosive devices, radioactive material, land mines and hazardous chemicals.

Recently-published reports describe how soldiers training for such missions found ARTHR-equipped robots more reliable and far easier to use than current threat-detection systems. And ARTHR responds to less cumbersome controllers, including lightweight PCs and handheld controllers such as Wii™ gaming remotes.

ARTHR has been selected to provide the "brains" for robots used by the U.S. Departments of Defense, Energy, Homeland Security and a variety of commercial entities. The invention is one of five technologies nominated for R&D Magazine's prestigious 2008 R&D 100 Awards, which recognize the most innovative ideas of the year.

ARTHR-generated hazard map showing radiation threat locations and exposure gradients from green (safe) to red (danger).

"Across several mission areas — including explosive detection, countermine operations and chemical detection — soldiers are now requesting the threat detection behaviors provided by ARTHR," said lead scientist David Bruemmer.

Where humans fear to tread
Soldiers and emergency responders often use robots to scout dangerous environments such as insurgent war zones, natural disasters and hazmat emergencies, including radiological and chemical accidents. Threat-detecting robots can explore the environment and locate potential hazards. In short, they tell the humans where it is safe and unsafe to go.

Robots used today require one human to operate the robot and another to hand-sketch its terrain and hazard readings. So threat characterization depends largely on operator skill and artistic ability. Mastering operation of the robots, which can have more than 16 degrees of freedom, requires months of training.

However, head-to-head tests revealed that INL's ARTHR system produced less performance variation among soldiers with different training and experience levels. ARTHR-enabled robots also improved both speed and accuracy of threat localization and eliminated collisions compared to conventional robotic systems. Laser mapping guarantees unparalleled accuracy in rendering a complete picture of the environment.

Enhancing robot abilities
ARTHR is a "plug-and-play" intelligence system that can be loaded onto a variety of commercially-available robots. The ARTHR payload enables robots to act more autonomously, freeing the user to focus on threat detection rather than robot operation.

And ARTHR creates its own maps of the hazards and surrounding environment — which makes barriers and safe zones easy to read. The accuracy is not affected by the sketching skills of the operator. Color-coded personnel safety zones represent plume tracing and source localizations as green, yellow and red to denote low, medium or high hazard readings, respectively.

The ARTHR system also allows simple point-and-click robot tasking, which lets the operator easily tell the robot, "look there," "sniff here" or "go there." ARTHR-equipped robots can be controlled by traditional command center units, which can weigh up to 30 pounds. Or operators can choose instead to use lightweight laptops, handheld devices or even Wii™ gaming remotes.

Head-to-head testing
The success of the ARTHR system in formal military tests has influenced military requirements for small unmanned ground vehicle payloads. Real-world experiments found that both novices and highly-trained military teams preferred ARTHR's accuracy and ease-of-use to traditional robots.

Head-to-head comparisons with state-of-the-art systems used by Army personnel found that ARTHR robots:

- Lowered mental demand and frustration of users, who trusted the system and predicted usefulness in the field.
- Produced no collisions in a 40-trial test, compared to 81 collisions with traditional controls.
- Completed chemical detection missions 52 percent faster and required 67 percent less operator interaction.
- Accurately localized 100 percent of radiation sources, compared to 57 percent with traditional controls.
- Detected and marked 96% of anti-tank land mines on a 50-meter path in a quarter of the time it takes a trained human.

What's next for ARTHR

ARTHR's ease of use and adaptability to commercial robots has earned the attention of numerous government agencies. And the President's Office of Science and Technology studied it as an example of effective research collaboration among federal agencies.

A program funded by the Office of the Secretary of Defense selected the INL technology to advance robotic capability for all branches of the military. And it is currently being evaluated for use in route-protection and chemical, biological, radiological and nuclear (CBRN) missions in Iraq.

ARTHR robots could also aid police departments, search-and-rescue personnel and border checkpoint agents. Domestically, the Government Training Institute endorsed the INL capability as the technology of choice in response to a Department of Homeland Security mandate for robots in all tier-one SWAT teams. Also, several lead robotics companies — including Foster-Miller, Northrop Grumman, iRobot and Segway — are all working to make the INL capability available on their products.

[Read INL's ARTHR fact sheet here](#).

[View INL's ARTHR video here](#).

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